Evaluation of the Rare-Element Pegmatites

in the Northwest Territories

SC 265569

PEGMATITE STUDIES IN THE ALYMER-MCKAY LAKE AREA, NORTHWEST TERRITORIES

Final Report

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Final Report

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March 1990

Introduction

Lithium, beryllium, cesium, tantalum and other elements typically concentrated in granitic pegmatites are metals with unique properties which make them irreplaceable in diverse energy-producing, -conserving and -storing techniques, and in numerous other technologies such as lightweight alloys and fatigue-resistant bronzes (Be), smelting of bauxite ore and lubricants (Li), pharmaceutic products (Li, Cs), magnetohydrodynamic experiments, iron engines and welding rods (Cs), electronic capacitors, jet engines, gas turbines and prosthetic devices (Ta). The rate of consumption of these metals is rapidly increasing, and is expected to skyrocket in the future, particularly when commercial nuclear power plants start operating.

Despite the competition from alternate geological sources, granitic pegmatites will maintain their importance as sources of the above metals, as well as others such as rubidium, gallium and tin. For this reason, our understanding of the economic potential of known but neglected pegmatite fields must be periodically upgraded, and the prospective value of essentially unexplored pegmatite fields must be examined to establish a reliable information bank on Canada's potential in mineral resources of tomorrow.

In the Northwest Territories, lithium resources have been recently re-assessed in the Yellowknife pegmatite field by Canadian Superior Exploration Ltd. (Lasmanis 1978). The tantalum potential and the general prospects of the field have also been examined (Wise et al. 1985, Wise 1987, Meintzer 1987). All this work has been broadening our understanding of a field that was discovered in the nineteen forties and

intermittently exploited, and subject to several research projects aimed at some of its segments (e.g., Hutchinson 1965, Kretz 1968, 1970, 1985, Kretz et al. 1982, 1989a,b.).

Outside the Yellowknife field, other pegmatite fields are located in the N.W.T. but the extant information about them is only rudimentary. Among these, the Aylmer-McKay Lakes contains mineralized granitic pegmatites dispersed over sizable areas that also show intrusions of possibly parental granites. The pegmatite population of the Aylmer-McKay Lake basin, although probably less dense that that of the Yellowknife field, covers a much larger area (cca. 28,000 km^2). However, all our present knowledge of the Aylmer-McKay pegmatites has been restricted till 1988 to the locations and terse notes in pioneering mapping reports.

Area of interest

The Aylmer-McKay Lake pegmatite field (Fig. 1) is located between 63-65° and 108-112°W. The area is covered by the geological maps Lac de Gras (Folinsbee 1947, 1949), Aylmer Lake (Lord and Barnes 1954), McKay Lake (Henderson 1943) and Walmsley Lake (Folinsbee 1952).

Several plutons of biotite-muscovite granites with local pegmatitic facies were mapped in this field, the most prominent one stretched from the SE end of Lac de Gras to the SE, to the W of Aylmer Lake (Fig. 2). Numerous pegmatitic granites were also recorded, notably at the N side of Thonokied Lake; at the central W and N parts of Aylmer Lake; and at Tarpon Lake.

Mineralized pegmatite bodies were marked at the following localities:

E of the SE end of Lac de Gras (Be);

at the SE end of Lac de Gras (Li);

at the NE end of McKay Lake (Li, Ta);

W of the N arm of Aylmer Lake (Li);

N of Muskox Lake (Ta, Nb);

in the corner between the N and W arms of Aylmer Lake (Li, Be);

N of Reid Lake and Margaret Lake (Be, Li);

southernmost extremity of Aylmer Lake (Be).

No mineralized pegmatites were recorded on the McKay Lake sheet, which is not necessarily indicative of their actual absence.

Objectives

The program initiated in 1988 had two different but complementary aims:

(i) to establish the nature, distribution and relationships of granitic pegmatites and related granites in the Aylmer Lake-McKay Lake field, and,

(ii) to provide guidelines for exploration.

Approach

Regional lithology and structure were reasonably documented but geochemistry and metamorphism were not. From this viewpoint, the objectives stated above were pursued through the following studies:

(1) the distribution, regional setting, mineralogy and geochemistry of the pegmatites;

(2) the spatial and material relationshps between the pegmatites and potential fertile granites.

Methods

In field:

(1) petrographic and geochemical sampling of the potential fertile granites;

(2) documentation of structural setting, internal structure and mineralogy of pegmatites;

(3) systematic geochemical sampling of the rock-forming and accessory minerals of the pegmatites.

In laboratory:

(1) chemical anaylsis of whole-rock samples for major and trace elements (Li, Rb, Cs, Be, Sn, Y, U, Th, Ga, Zr, Be, Sr, Pb); selected samples for REE and oxygen isotopes;

(2) chemical analyses of K-feldspar, muscovite and beryl for Li, Na, K, Rb, Cs, Ca, Be, Pb, Fe, Mg; partial chemical analyses of additional species as required;

(3) thin section study of rock samples, polished section study of opaque accessory minerals, optical and XRD identification of accessory minerals;

(4) electron microprobe analysis of accessory minerals (Nb, Ta-oxide minerals garnet, etc.);

(5) special investigations to characterize genetically important features of individual species (order-disorder in K-feldspar, columbite-tantalite; polymorphism in micas; etc.).

Work accomplished

In 1988, the field season covered pegmatites in the central and southern parts of the Aylmer Lake basin. Most of the previously known

localities were examined and considerably expanded, and many new pegmatite occurrences were discovered. A total of 66 pegmatites was examined in 2/3 of the territory in which only 11 localities were registered in the nineteen forties and fifties. Sixty-seven of the presently identified pegmatites carry abundant spodumene, 33 contain appreciable beryl, and 15 have accessory Nb, Ta-oxide minerals.

Sampling of the plutonic rocks was very sketchy in 1988, as the initial work was focused on the economically interesting objects of the study, the (mineralized) pegmatites.

In 1989, field work was essentially concluded. Over and above the pegmatites and plutonic intrusions examined in 1988, additional 148 pegmatite dikes were discovered and sampled, and 18 granitic intrusions were sampled in the vicinity of pegmatite concentrations.

Due to the loss of the 1987 field season, over-abundance of pegmatite localities in the Aylmer Lake part of the field, and restricted funding which did not permit activities above the level of one 2-man party per field season, the original objectives have been scaled down to the Aylmer Lake segment of the field.

The overabundance of localities has also required a much more extensive geochemical program than originally anticipated, requiring extended sample preparation for chemical analysis. Separation and analysis were made possible through additional funding which became available only in February 1990. For these reasons, the geochemical data, analysis and interpretation will be supplied only in the summer of 1990.

Plutonic rocks

Figure 2 summarizes sampling of granitic intrusions in the Aylmer Lake area. Examination of granites was aimed at leucocratic, two-mica ($\pm$ garnet, tourmaline) granites in the general vicinity of pegmatite populations, and on selected large intrusions of similar character which were recognized in early mapping projects of the nineteen forties and fifties but not examined in detail.

Most of these granites are sharply intrusive into their metasedimentary host rocks. Fine-grained to medium-grained, locally K-feldspar megacrystic plutons commonly have border facies of very coarse-grained to pegmatitic (including graphic) texture. Tourmaline and apatite tend to be locally enriched in this facies.

Individual intrusions, probably related to specific pegmatite populations, will be commented on in conjunction with pegmatite descriptions below.

Pegmatite populations

Figure 3 shows distribution of the specific pegmatite populations examined in the Aylmer Lake area. They are the Aylmer Lake and Nebbish Lake (Fig. 4), Reid Lake (Fig. 5), Thonokied Lake (Figure 6) and Kirk Lake (Fig. 7) pegmatite series and groups.

Aylmer Lake

A total of 36 granitic pegmatites was examined at the junction of the western and northern arms of Aylmer Lake (Fig.4). The pegmatites intrude metasedimentary schists, and they seem to form an envelope surrounding a pegmatitic leucogranite which outcrops as an island in the lake (Fig. 4). Their dimensions are variable from 3 x 5 m to 7 x 140 m,

with a small number of dikes reaching 170 m in length. The pegmatites carry mainly beryl, in some cases also columbite-tantalite, and a number of dikes (largely not shown in Fig. 4) are barren. As shown in Fig. 4, there does not seem to be any discernible regional zoning developed in this pegmatite series. This is understandable in terms of its narrow range of fractionation: the barren to beryl-columbite and beryl-columbite-phosphate subtypes do not allow for extensive paragenetic and geochemical differences (Table 1). However, it should be noted that the western cluster of pegmatites contains widespread alteration products of triphylite-lithiophilite, as opposed to a single locality of this mineral to the north-to-east from the central pluton. The western pegmatite cluster seems to be the most evolved (despite the paucity of columbite-tantalite), and it also is the most remote one from the potentially parent granite.

Another series of pegmatites was found in the southern part of Aylmer Lake (Fig. 4). Two pegmatites contain columbite-tantalite plus beryl, one has beryl only (Table 1). The largest intrusion measures 5 x 12 m in outcrop. This pegmatite population is too small to indicate any regional zoning. Two granite intrusions outcrop in close vicinity, to the south and to the east from the pegmatite location. The southern pluton is a good candidate for an intrusion parental to this pegmatite series, as it contains a sizeable unit of pegmatitic leucogranite. It also is much closer to the pegmatites than the granite to the east. More fractionated pegmatites may thus be located to the north of those examined so far.

Nebbish Lake

A total of 16 mineralized pegmatites was identified in this area. The pegmatites are scattered over a sizable area. Most of them are close to one or another of two small granitic plutons northwest and southeast of Nebbish Lake, but two dikes are relatively close to a large granitic intrusion northeast of the lake (Fig. 4). The outcrop southeast of Nebbish Lake is an obvious candidate for a parent intrusion because of its largely pegmatitic character. The small granitic exposure to the northeast of Nebbish Lake is an equigranular two-mica granite with blue-green apatite, but the pluton to the northwest of Nebbish Lake is a homogeneous biotite granite. Geochemical signatures of these 3 granites will be required to separate barren and fertile intrusions. However, if the granites are closely related among each other, the pegmatites may not be related to a specific outcropping body. The two small granite outcrops in the southwest may represent tops of domes that are connected below the present erosion surface with the main northeastern intrusion.

The distribution of the pegmatite types is rather nondescript, with no apparent regional zoning pattern. This may also indicate a widespread batholithic granite subjacent to the metasediments hosting the pegmatites.

Four dikes contain beryl, columbite-tantalite was found with beryl in one pegmatite, and eleven dikes carry spodumene (Table 2). The four Li-bearing dikes to the south and east of the lake are particularly rich in spodumene. The outcrop dimensions of the pegmatites range from 5 x 12 m to 7 x 100 m.

Six pegmatite dikes with abundant spodumene are located in an equigranular two-mica granite of the intrusion southeast of the lake, in its southern margin (Fig. 4). Besides spodumene, these pegmatites contain abundant saccharoidal albite, and locally amblygonite-montebrasite and beryl. All six pegmatites show complex internal zoning, one dike particularly so. Outcrops of these individual pegmatites range from 3 x 5 m to 8 x 50 m.

Sampling of granitic intrusions covered the three bodies located to the northwest, northeast and southeast of Nebbish Lake.

Reid Lake

A total of 6 barren and 9 mineralized pegmatites were inspected in this area, principally around the two lithium-bearing pegmatites reported in the literature, at the northern part of the lake (Fig. 5). Four of the dikes contain abundant spodumene; they are in part irregular in shape, with a maximum length of 100 m, but one elongate body reaches 20 x 230 m.

Three beryl-bearing and one columbite + beryl-bearing pegmatites are located in the central part of Reid Lake, whereas a single beryl-bearing dike is associated with a number of barren ones at its southern end. These pegmatitic outcrops range from 2 x 8 m to 5 x 12 m in size.

The above distribution of pegmatites suggests a progressive regional zoning northwards, but over a distance which is much in excess of cogenetic zoned groups. However, two-mica pegmatitic leucogranites outcrop to the south of Reid Lake, as well as in its central parts at the beryl-bearing pegmatitic cluster. An apatite-rich, complex

intrusion with two-mica, muscovite, and pegmatitic granite facies also outcrops E-NE of the pegmatite population, west of Zyena Lake, forming the southermost extremity of the batholithic intrusion stretched to Lac de Gras (Fig. 2,5). Geochemical studies may show all these granites mutually related.

Thonokied Lake

A total of 118 individual pegmatite dikes were identified, intruding an expanse of approximately 30 km^2 of nodular schists on the north side of this lake (Fig. 6). Of these, mineral samples were taken from approximately 50, in the form of three traverses through the pegmatite group. The pegmatites in the southern part of the area are commonly beryl-bearing, whereas no beryl was found in the pegmatites of the northern traverse. A single beryl-bearing dike was found far to the north of the traversed group and close to the contact with two-mica granite (pegmatitic) which lies to the north.

Pegmatites in this area typically trend parallel or subparallel to metamorphic schistosity of country rocks (generally east-west, and slightly northeast) and are steeply dipping. Sizes are variable from tiny stringers up to 20 x 250 m. Further beryl-bearing and barren pegmatites (of which 4 were sampled) lie just west of the group proper, and some are oriented similarly to their eastern counterparts.

A total of five possibly separate plutons were sampled extensively in this area. In these plutons a variety of granitoids was found, ranging from biotite granodiorite (or tonalite) to less primitive garnet- and/or apatite-bearing leucogranites. Due to complexity of granitoids surrounding the central pegmatite group, identification of

parental granite(s) will only be possible with a detailed geochemical profile of all granitoids, if at all. The overall uniformity of pegmatites in this area suggests a more or less continuous granitic material beneath a rather thin mantle of metasediments.

Kirk Lake

A series of apparently barren pegmatites was examined in this area, concentrated around the northern end of the lake and surrounding a granite pluton situated there (Fig. 7). The pegmatite outcrops range from 3 x 6 m to 5 x 20 m in size. Only one of the pegmatites contains lazulite (Fig. 7).

If the pegmatites prove to be genetically related to the pluton central to their distribution, in the northern part of Kirk Lake, detailed examination of the outskirts of the know pegmatite population will be warranted. More fractionated and mineralized bodies may be located at a greater distance from the granitic parent. The granitic intrusion situated in the northern part of Kirk Lake is a good candidate for the pluton parental to the pegmatite population, as its western segment shows a gradation from a fine-grained biotite facies in the south to a pegmatitic leucogranite phase to the north, facing the pegmatites.

Granites to the east of previously-detailed lazulite-bearing pegmatites (west of Taylor Lake) were also sampled in some detail. Most of the outcrops are comprised of coarsely pegmatitic leucogranite, often carrying apatite in nodules. Again, as in the above-described cases of Nebbish Lake and Reid Lake, the different (pegmatitic) leucogranites may prove to be mutually related on geochemical examination.

Muskox Lake

A single pegmatite is located at Muskox Lake (Fig. 3), reported previously to contain columbite-tantalite. The outcrop of this dike is 5 x 10 m in size, in part aplitic, in part coarse pegmatitic with conspicuous quartz pods. It contains a black opaque mineral resembling columbite-tantalite but otherwise no other rare-element minerals. Aerial inspection of the vicinity did not reveal any other pegmatite outcrops.

Evaluation of the Aylmer Lake pegmatitic population

On the basis of field examination, subject to modification by geochemical interpretations, the economically most promising pegmatitic population is that surrounding Nebbish Lake. This is indicated first of all by the abundance of spodumene-bearing pegmatites, by the well zoned internal structure of many of them, and by the abundance of saccharoidal albite in some. Another indicator is the presence of some of the spodumene-bearing dikes in the outcrop of a two-mica, in part pegmatitic leucogranite, suggesting strong telescoping of the local granite + pegmatite system(s). Finally, several outcrops of leucogranites around Nebbish Lake, two apparent line-ups of granites and pegmatites in the NW-SE direction (one of these also aligned with the central pegmatitic leucogranite at Aylmer Lake; Fig. 4) suggest an undulating subsurface granite body, expressed at the erosion level by a few isolated cupolas. The area has a potential for additional highly fractionated pegmatite bodies, either outcropping in bedrock exposure but covered by glacial overburden, or hidden within the metamorphic rocks overlying the granites.

Reid Lake area also deserves attention. Although the known pegmatites do not seem to be as highly fractionated as those at Nebbish Lake, the area shows many analogies with the latter (Fig. 5). Numerous outcrops of fertile-type leucogranites, commonly pegmatitic and spodumene-rich pegmatites at considerable distance from any outcropping granites suggest again a granite subjacent to sizeable areas of metasediments, with consequent lack of clear-cut regional zoning in the pegmatite population. Hidden mineralized pegmatites, and pegmatitic outcrops covered by surface overburden are a distinct possibility.

In contrast to the two pegmatite series above, the pegmatitic population between the northern and western areas of Aylmer Lake (and that located in the southern part of the lake) is only moderately evolved. Spodumene-bearing pegmatites cited in the literature were not confirmed, occurences of columbite-tantalite visible in hand specimen are highly sporadic, and beryl does not seem to be accumulated in any of the dikes to an economically interesting level.

Thonokied Lake area, despite its considerable extent, is poorly mineralized and nearly homogenous, and relatively rich in small outcrops of pegmatitic leucogranite. It represents either a granite + pegmatite system with overall primitive geochemistry, or a deeply eroded system exposed at the level of its least fractionated roots.

The same applies to the Kirk Lake area, with the significant difference that its pegmatite distribution seems to be tightly wrapped around one particular granite intrusion. Overall accessory mineralogy is extremely primitive. However, hidden or covered pegmatites with higher degree of fractionation may be present at a greater distance from

the granite central to the known pegmatitic outcrop, if this one is their magmatic source.

The nature of the Muskox Lake pegmatite and its mineralization is not understood enough at present.

Recommendations

The pegmatite area at Nebbish Lake, and particularly the leucogranite and spodumene pegmatite cluster southeast of the lake, deserve further study.

If the Muskox Lake pegmatite proves to be enriched in columbite-tantalite, its broader vicinity should be examined in detail which could not be afforded during the present study.

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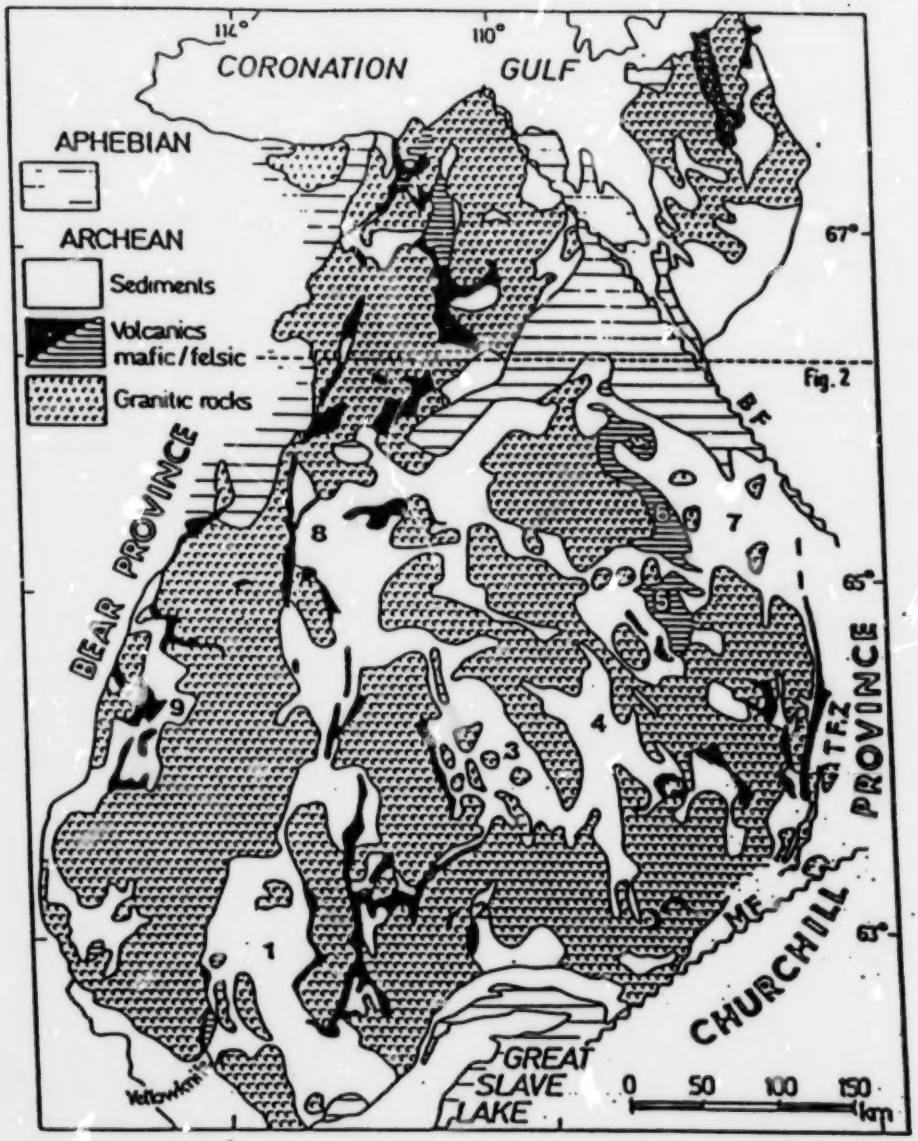
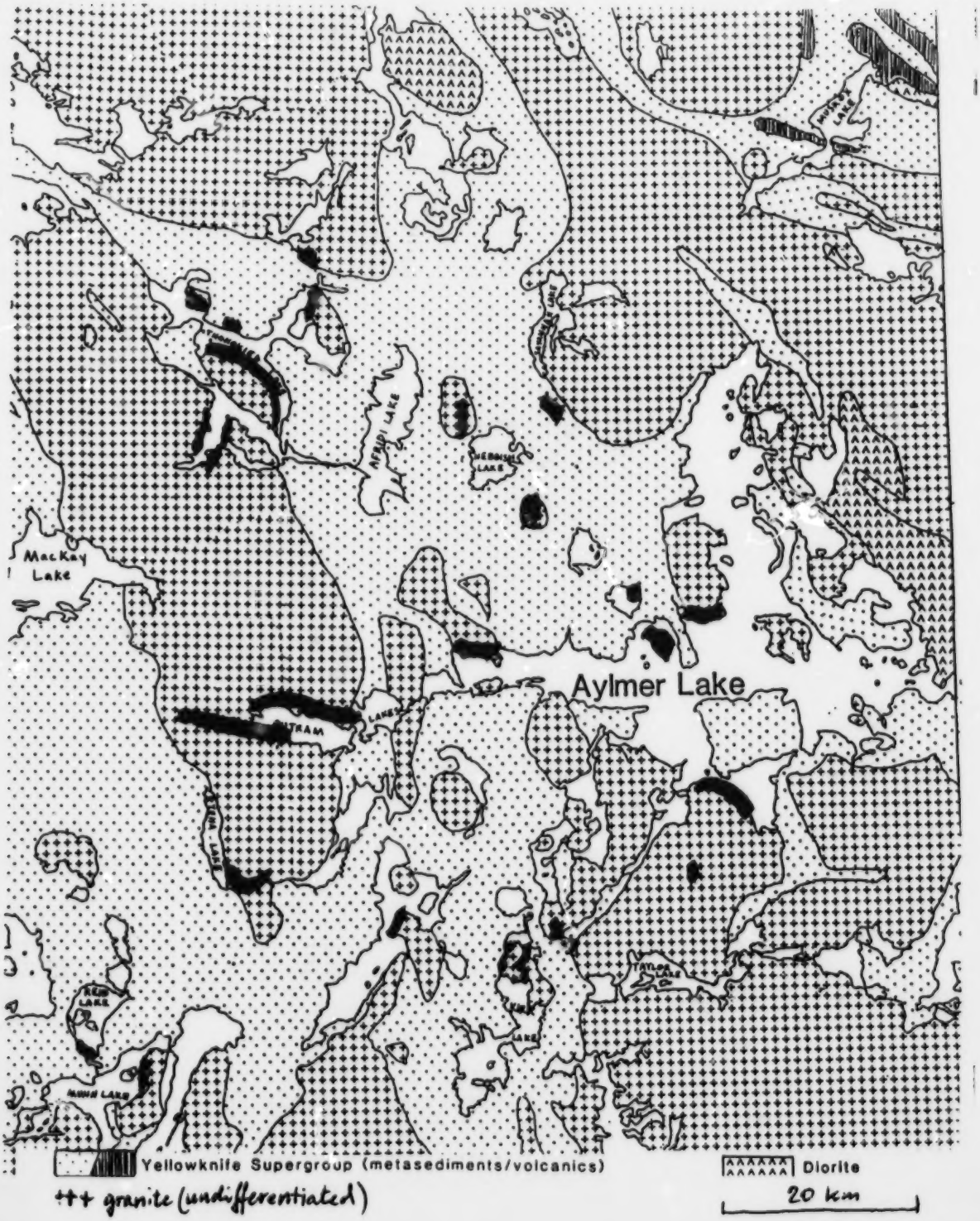


Fig. 1. Location of the Aylmer Lake-McKay Lake pegmatite field (4 and 3) in the Slave Province.

Fig. 2. Sampling of granitic intrusions in the Aylmer Lake basin; dots marking sample locations emphasized by highlighting.



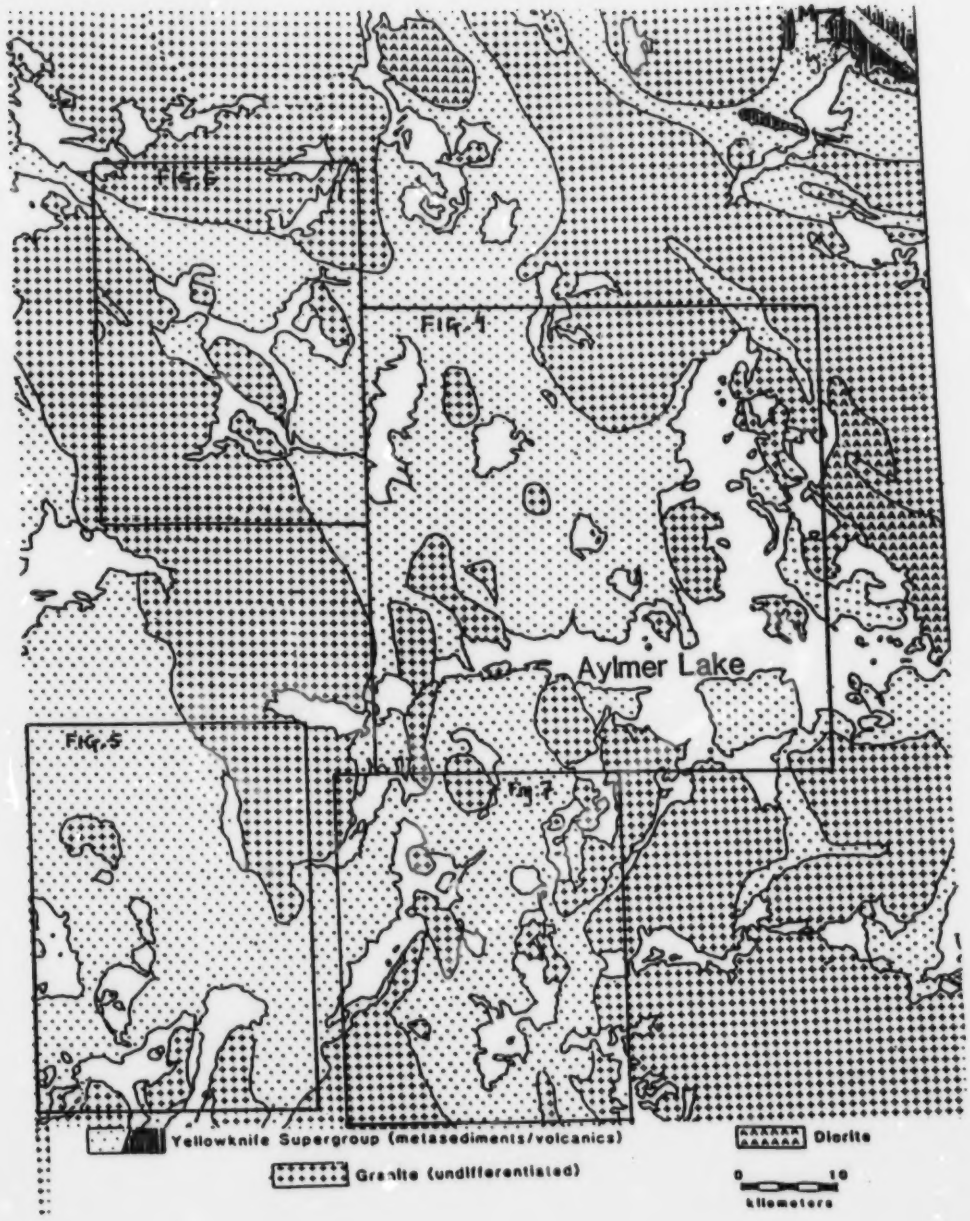


Fig 3. Index map of the Aylmer Lake basin, showing the disposition of the location maps of Aylmer Lake and Nebbish Lake (Fig.4), Reid Lake (Fig. 5), Thonokied Lake (Fig. 6), Kirk Lake (Fig. 7) and Muskox Lake (M).

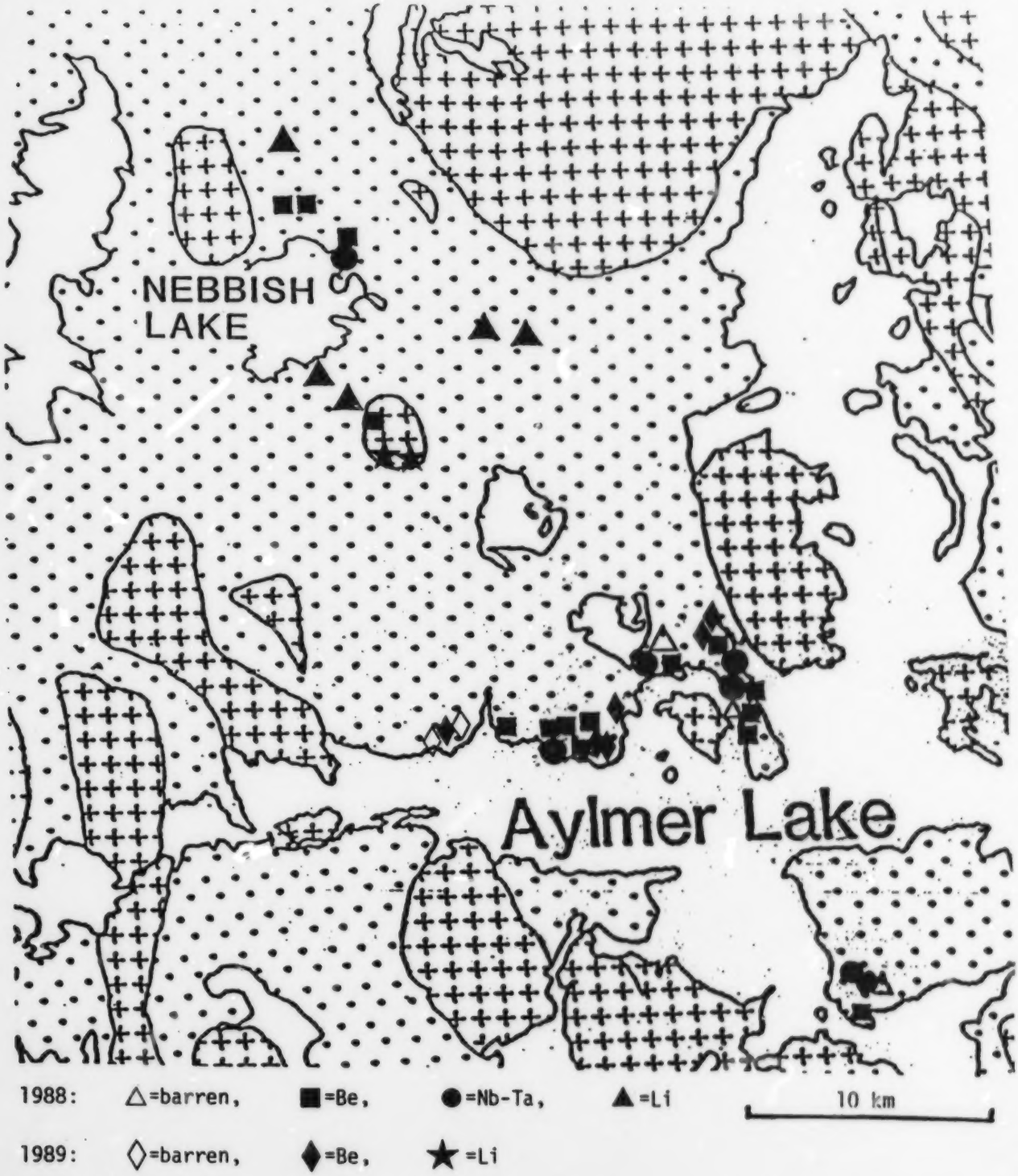
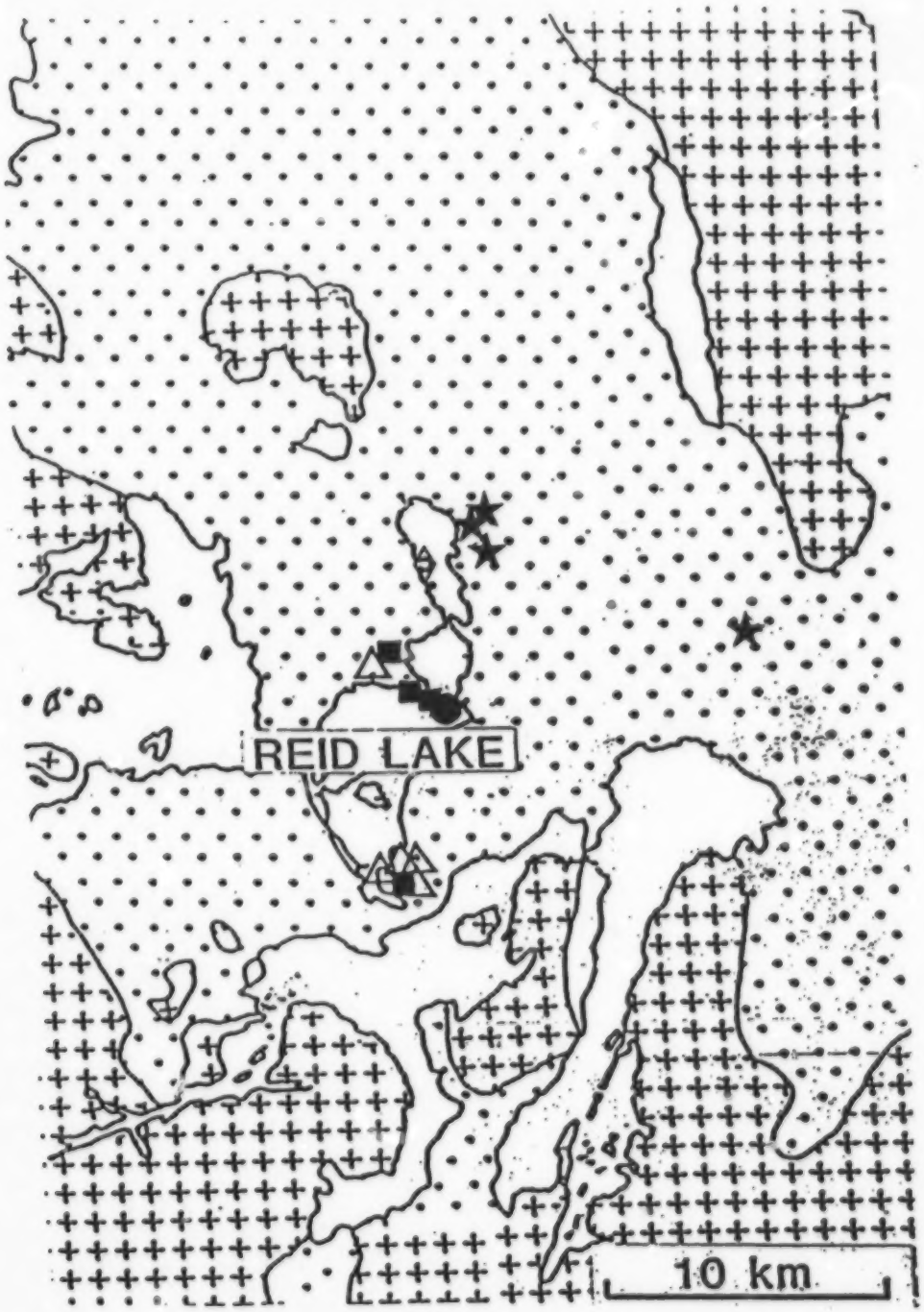


Fig. 4. Location map of pegmatite occurrences at Aylmer and Nebbish Lake, using separate symbols for pegmatites investigated in 1988 and 1989.



1988: △=barren, ●=Nb-Ta, ■=Be

1989: ◇=barren, ★=Li

Fig. 5. Location map of pegmatite occurrences at Reid Lake, using separate symbols for pegmatites investigated in 1988 and 1989.

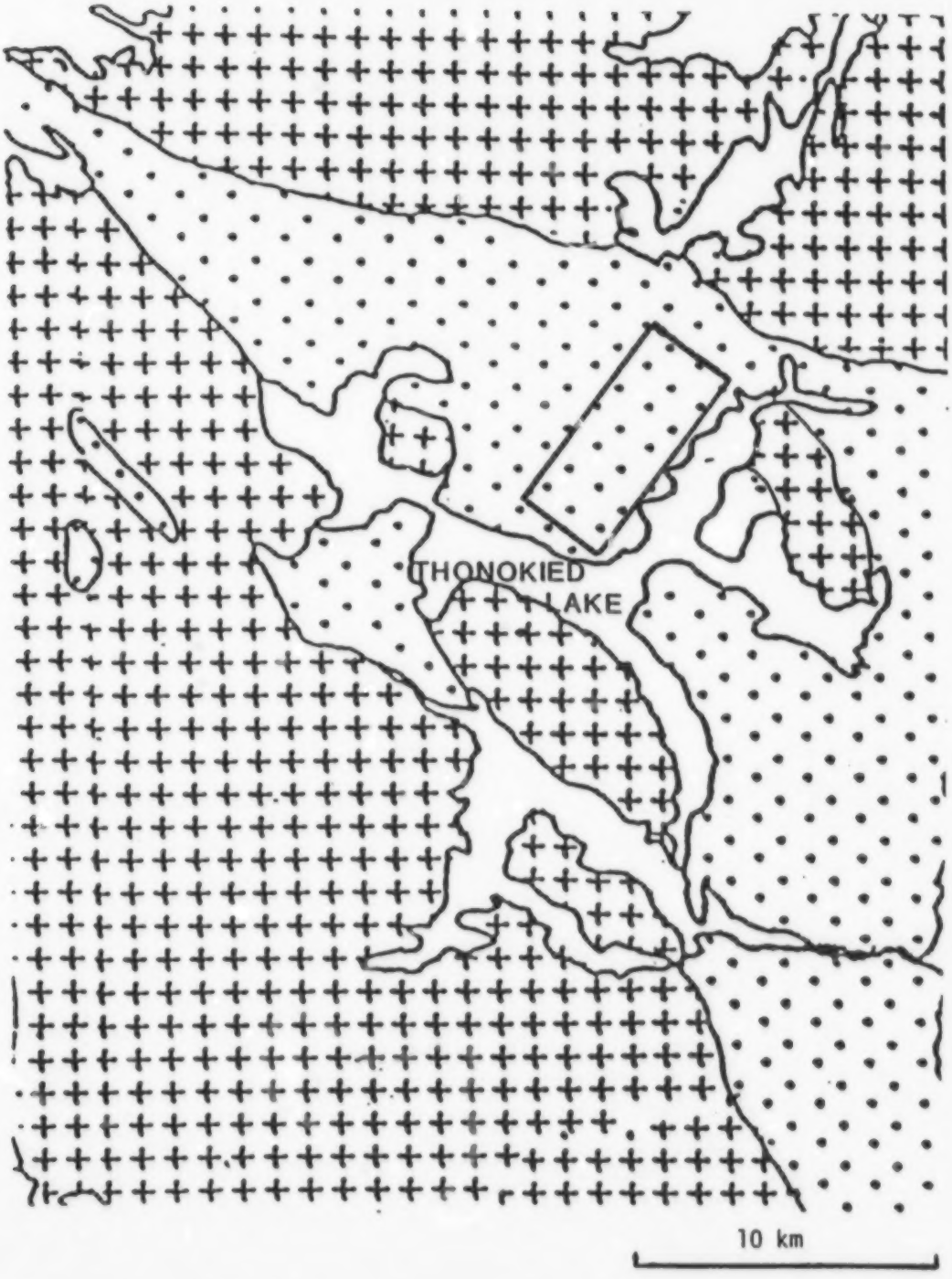


Fig. 6. Location map of the pegmatite group at Thonokied Lake. The rectangular region is the rough boundary of the pegmatite population.

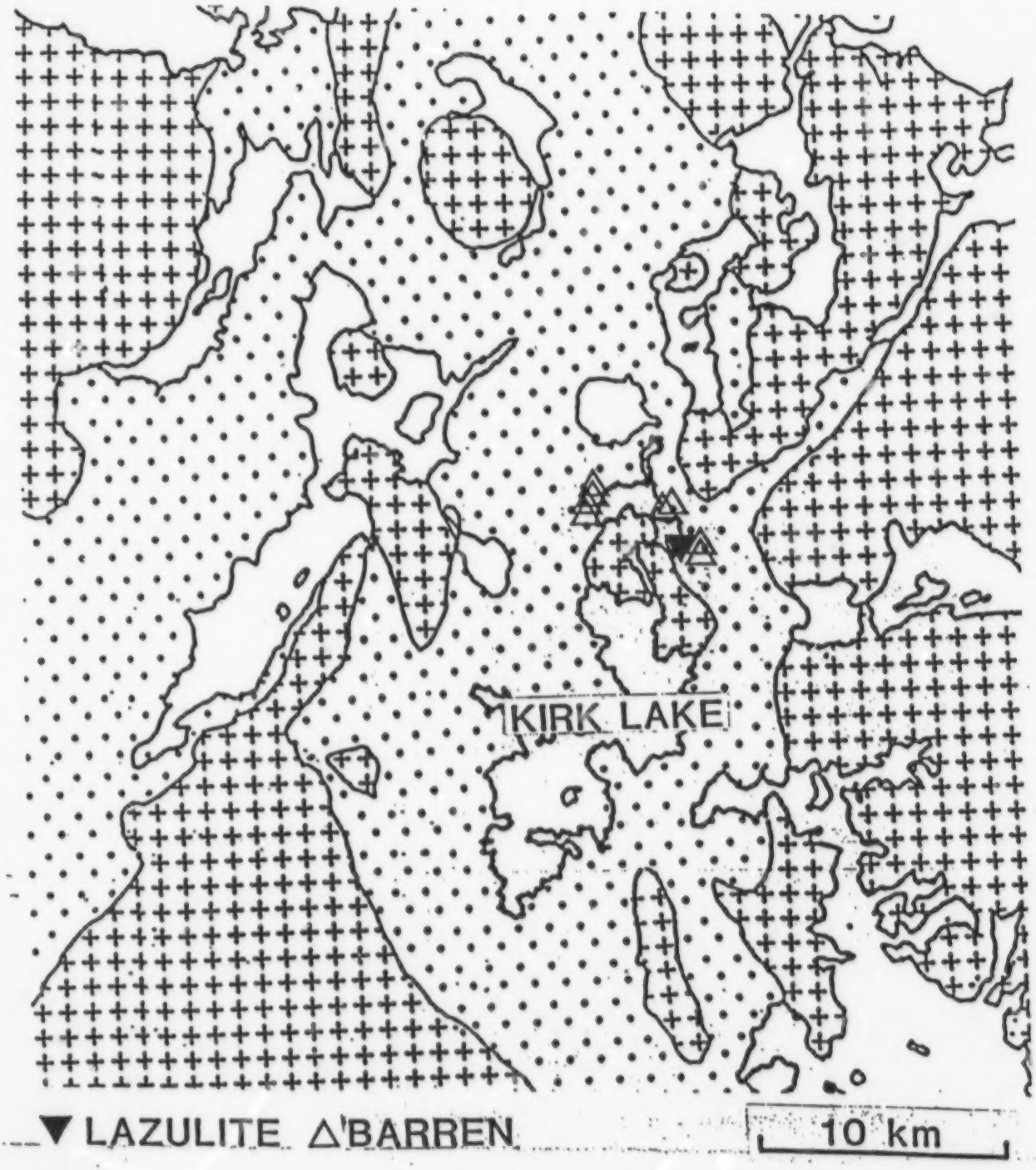


Fig. 7 Location map of the pegmatite occurances at Kirk Lake.